IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Application of:

Anandaroop Bhattacharya et al.

Application No.: 10/723,533

Filed: November 26, 2003

For: THERMAL MANAGEMENT DEVICE FOR AN INTEGRATED CIRCUIT

Examiner: Chervinsky, Boris Leo

Art Unit: 2835

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APPELLANT'S SUPPLEMENTAL APPEAL BRIEF

TO THE HONORABLE COMMISSIONER FOR PATENTS:

This brief is in support of a Notice of Appeal to the Board of Patent Appeals and Interferences filed on October 27, 2006, appealing the decision of the Examiner in the Office Action mailed August 16, 2006 ("Office Action"), in which the claims of the above-captioned application were rejected for a second time. Appellant respectfully requests consideration of this appeal by the Board of Patent Appeals and Interferences ("BPAI") for allowance of the present patent application.

SUPPLEMENTAL MATERIAL

In response to the Notice of Non-Compliant Appeal Brief mailed February 13, 2007, Appellant herein presents this Supplemental Appeal Brief, which includes a statement indicating the cancelled status of claims 1-31.

I. REAL PARTY IN INTEREST

The real party in interest in the above-identified application is Intel Corporation of Santa Clara, CA.

II. RELATED APPEALS AND INTEREFERENCES

The Appellant's undersigned attorney and the assignee identified above are not aware of other appeals or interferences that would directly affect or be directly affected by, or have a bearing on the BPAI's decision in the subject appeal.

III. STATUS OF CLAIMS

Claims 1 - 31 cancelled.

Claims 32 - 58 stand rejected under 35 U.S.C. § 103(a) and are presently appealed. The claims were rejected in view of Ozmat (U.S. Patent No. 5,402,004) (hereinafter "Ozmat") and Dessiatoun (U.S. Patent Application No. 2003/0227732) (hereinafter "Dessiatoun") and further in view Landin et al. (U.S. Patent No. 6,410,160) (hereinafter "Landin").

IV. STATUS OF AMENDMENTS

No amendments have been filed subsequent to the Office Action.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 32 is directed towards an apparatus having a die including at least one integrated circuit and a surface; a heat exchanger; and a thermal management device having a case with a plate attached to the surface of the die and a cavity, and a porous medium disposed within the cavity of the case and attached to the plate, the thermal management device to allow for a fluid to flow through said porous medium to thermally coupled the die to the heat exchanger.

Figure 1 and associated discussion describe an apparatus recited in claim 32 in accordance with an embodiment. In particular, a die including at least one integrated circuit and a surface may be described in accordance with an embodiment in paragraph [0010], e.g., a "heat source **24** could include an integrated circuit …in a die." A heat exchanger may be described in accordance with an embodiment in paragraph [0009], e.g., the heat source **24** may be thermally coupled to a remote heat exchanger. A thermal management device may be described in accordance with an embodiment in paragraphs [0009] and [0012], e.g., thermal management device **38** including a case **48** with a plate and a porous medium **56** disposed within the case **48** and attached to a plate of the case **48** (the bottom portion of the case). See also, paragraph [0016]. The plate of the case **48** may, in turn, be attached to the die. See, e.g., paragraph [0021]

Independent claim 46 is directed towards an apparatus having a die including at least one integrated circuit; a heat exchanger; and a thermal management device having a case including a cavity and a microporous medium attached to the die and disposed within the cavity, the thermal management device to allow for a fluid to flow through said porous medium to thermally couple the die to the heat exchanger.

Figures 1, 2(a), and 2(b) and associated discussion describe an apparatus as recited in claim 46 in accordance with an embodiment. In particular, a die including at least one integrated circuit may be described in accordance with an embodiment in paragraph [0010], e.g., a "heat source **24** could include an integrated circuit …in a die." A heat exchanger may be described in accordance with an embodiment in paragraph [0009], e.g., the heat source **24** may be thermally coupled to a remote heat exchanger. A thermal management device may be described in accordance with an embodiment in paragraph [0025], e.g., a thermal management device **64** having a case **70** with a cavity **72** and a microporous medium **56** attached to the die and disposed within the cavity **72**.

Independent claim 50 is directed towards a method comprising operating an integrated circuit within a die, leading to heat being sourced from the die; and flowing a

flui9d through a porous medium housed in and filling a cavity of a case that is attached to the die, to transfer thermal energy away from the die.

Figure 1 and associated discussion describe a method recited in claim 50 in accordance with an embodiment. In particular, operating an integrated circuit within a die may be described in accordance with an embodiment in paragraphs [0009] and [0010], e.g., a heat generated by a heat source **24**, which could include an integrated circuit formed in a die. Flowing fluid through a porous medium housed in and filling a cavity of a case that is attached to the die may be described in accordance with an embodiment in paragraphs [0012], [0016], and [0021] e.g., the pump may create a pressure change to at least assist the flow of the cooling fluid from the inlet **40** to the outlet **44** through the porous medium **56**; the porous medium **56** may be housed in and filling a cavity of a case **48**; the case may be attached to the die.

Independent claim 54 is directed towards a system having an electronic assembly including a die with at least one integrated circuit and a surface; a heat exchanger; and a thermal management device with a case including a plate attached to the surface of the die and a cavity, and a porous medium disposed within the cavity of the case and attached to the plate, the thermal management device to allow for a fluid to flow through said porous medium to thermally coupled the die to the heat exchanger. The system of claim 54 may also include dynamic random access memory (DRAM) and an input/output (I/O) interface coupled to the integrated circuit.

Figure 1 and associated discussion describe an electronic assembly recited in claim 54 in accordance with an embodiment, while Figure 4 and associated discussion describe the electronic assembly in the system context of claim 54 in accordance with an embodiment. In particular, a die including at least one integrated circuit and a surface may be described in accordance with an embodiment in paragraph [0010], e.g., a "heat source **24** could include an integrated circuit …in a die." A heat exchanger may be described in accordance with an embodiment in paragraph [0009], e.g., the heat source **24** may be thermally coupled to a remote heat exchanger. A thermal

management device may be described in accordance with an embodiment in paragraphs [0009] and [0012], e.g., thermal management device **38** including a case **48** with a plate and a porous medium **56** disposed within the case **48** and attached to a plate of the case **48** (the bottom portion of the case). See also, paragraph [0016]. The plate of the case **48** may, in turn, be attached to the die. See, e.g., paragraph [0021]. The DRAM and I/O interface may be described in accordance with an embodiment in paragraph [0030], e.g., memory **102** may include DRAM and I/O modules **108**.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Whether claims 32 – 39 and 41 – 58 are unpatentable under 35 U.S.C. § 103(a) over Ozmat in view of Dessiatoun.

Whether claim 40 is unpatentable under 35 U.S.C. § 103(a) over Ozmat and Dessiatoun and further in view of Landin.

VII. ARGUMENT

REJECTIONS UNDER 35 U.S.C. § 103 - CLAIMS 32 - 58

The Examiner's rejections were all based on at least Ozmat in view of Dessiatoun. The Examiner failed to develop a sufficient factual basis to support a *prima facie* case of obviousness.

As is well established, the Examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. See MPEP 2142. To establish a *prima facie* conclusion of obviousness the factual basis must show (1) a suggestion or motivation to combine the teachings of the references; (2) a reasonable expectation of success; and (3) the combined teachings must teach or suggest all of the claim limitations. Id; see also MPEP 706.02(j). The Supreme Court set out the inquires necessary to develop this factual basis in *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). See also MPEP 2141. These inquiries include determining the scope and

content of the prior art; ascertaining the differences between the prior art and the claims at issue; and resolving the level of ordinary skill in the art.

The Examiner has clearly failed to provide a sufficient factual basis to support a *prima facie* case of obviousness.

A. Graham Inquiries

1. Determining Scope and Content of Prior Art

Ozmat teaches chips **3**, **7**, and **9** coupled to a substrate **11**, which is, in turn, coupled to a metal matrix composite (MMC) plate **13**. The MMC plate **13** acts to distribute the heat produced by the chips along the substrate **11**. The MMC plate **13** is coupled to an aluminum sponge **19** and a cooling fluid is flowed through the sponge **19** from an intake **21** to an outake **23**. See Figures 2 and 3 of Ozmat and associated discussion in column 2, line 35 to column 3, line 64.

Dessiatoun teaches heat sources **26** and **28** coupled to a heat transfer module **12**. The heat transfer module **12** includes a circulating unit **38** to facilitate coolant flow **30** through pin fins **24** of variable densities from an inlet **32** to an outlet **34** and ultimately to a cooling unit **36**. See Figures 1 and 2 of Dessiatoun and associated discusion in paragraphs [0050] to [0055]. The variable densities of the pin fins **24** allow the heat transfer module **12** to focus heat transfer resources to the localized heat sources **26** and **28** without wasting the resources on the remainder of the circuit board which does not need heat transfer. See paragraph [0087].

2. Ascertaining Differences Between Prior Art and Claims at Issue

Ascertaining the differences between the prior art and the claims at issue requires interpreting the claim language, and considering both the invention and the prior art references as a whole. See MPEP 2141.02.

As discussed above, claim 32, for example, recites that a porous medium is attached to a plate of a thermal management device, with the plate, in turn, being attached to a surface of a die.

One skilled in the art interpreting the Ozmat and Dessiatoun references as a whole, would clearly realize that both of these references teach that thermal management devices are thermally coupled to dice through one or more interposing elements, rather than being attached to the surface of the dice.

Regarding Ozmat, the interposing elements between chips **3**, **7**, and **9** and the plate **13** of the thermal management device include at least the solder balls (shown in Figure 3, but not discussed) and the substrate **11** (e.g., a printed circuit board), and the MMC plate **13**. Furthermore, even if the plate were attached to the surface of the chips **3**, **7**, and **9**, there would still be interposing elements between the plate **13** and the surface of the die. This is because the chips **3**, **7**, and **9** discussed in Ozmat correspond to the 1st level package (including a die and a carrier substrate) discussed in paragraph [0010] of the present specification.

While the Figures of Dessiatoun do not show much detail, one skilled in the art interpreting Dessiatoun as a whole would understand it to teach attaching a thermal management device to a circuit board, similar to Ozmat, not directly to a surface of a die. See, e.g., paragraph [0087], "As is the usual case in the electronic circuitries, the heat sources are discrete and localized. The remaining portion of the circuit board generally requires little or no cooling." Thus, the heat transfer module **12**, which is attached to the entire circuit board, is customized to provide heat transfer resources to the areas of the circuit board where the chip packages (i.e., the heat sources **26** and **28**) reside. Furthermore, similar to Ozmat, the heat sources **26** and **28** correspond to 1st level packages, not to die, and therefore there exists other interposing elements, e.g., carrier substrate, solder balls, etc.

Accordingly, claim 32 differs from these references for at least these reasons. Claims 33 – 45 and 50 – 58 depend from, or include limitations similar to, claim 32.

Therefore, these claims differ from these references for at least the same reasons as claim 32. These claims also add additional elements which differ from the combined teachings of these references such as, but not limited to:

- with respect to claim 34 – the porous medium being configured based at least in part on a non-uniform heat distribution over the surface of the die;
- with respect to claims 39 and 56 - the porous medium having different pore diameters corresponding to different thermal outputs of areas of the die;
- with respect to claim 42 - the pump facilitating a fluid flow at rate to result in two-phase flow; and
- with respect to claim 43 - a substrate coupled to the die on the side opposite the thermal management device.

As discussed above, claim 46, for example, recites that a microporous medium is attached to the die and disposed within a cavity of the thermal management device.

One skilled in the art interpreting the Ozmat and Dessiatoun references as a whole, would clearly realize that neither of these reference teach a microporous medium, much less one that is attached to the die.

One skilled in the art would recognize that neither of these references suggest a porous medium attached to a die for reasons similar to those given above. That is, with respect to Ozmat, the porous medium **19** is coupled to dice found in the IC chips **3**, **7**, and **9** through a number of interposing structures, e.g., plate **13**, substrate **11** (e.g., PCB), carrier substrate, solder balls, etc. Similarly, with respect to Dessiatoun, the pin fins **24** are coupled to dice found in the heat sources **26** and **28** through a number of interposing structures, e.g., a circuit board, carrier substrate, solder balls, etc.

Furthermore, one skilled in the art would recognize that neither of these references suggest a microporous medium. The micro-scale of the pore size of the

medium is not discussed in either of the cited references. Dessiatoun teaches compressed springs with the smallest diameter being 0.6 millimeters (mm). See paragraph [0075]. Ozmat teaches a structure similar to steel wool, with a preferred structure of about 10% density. An artisan would recognize that neither of these structures correspond to a microporous medium as this element would be interpreted in light of the present specification.

Accordingly, claim 46 differs from these references for at least these reasons. Claims 47 – 49 depend from claim 46. Therefore, these claims differ from these references for at least the same reasons as claim 46. These claims also add additional elements which differ from the combined teachings of these references such as, but not limited to:

- with respect to claim 47 – a sealant to at least facilitate a watertight seal between the case and the die;
- with respect to claim 48 – porous medium being attached to the die with a thermal interface material;
- with respect to claim 49 – the porous medium having dimensions similar to the die.

3. <u>Resolving the Level of Ordinary Skill in the Art</u>

A person of ordinary skill in the art is a person having general knowledge about the field of thermal management in computer systems.

B. <u>*Prima Facie* Analysis</u>

<u>The Examiner has failed to show a *prima facie* case of obviousnessas required for a rejection under 35 U.S.C. § 103.</u>

As discussed above, the Examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. See *MPEP* 2142. "To support the

conclusion that the claimed invention is directed to obvious subject matter, either the references must expressely or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (BPAI 1985). The Examiner has failed to meet this burden with at least each of the noted differences identified above in section VII.A.2.

As discussed above with respect to claim 32 (and claims 33 – 45 and 50 – 58), Ozmat and Dessiatoun fail to expressely or impliedly suggest that the porous medium is attached to the plate of the thermal management device, with the plate, in turn, being attached to the surface of the die. The Examiner has also failed to provide an argument as to why an artisan would be motivated to modify either of these references to correct for their deficiencies, much less a convincing line of reasoning. In fact, the Office Action makes no mention of this limitation at all.

Nothwithstanding Examiner's failure to provide the requisite reasoning in light of the clear deficiencies of the teachings of the cited references, an examination of the cited references in light of the prior art knowledge at the time of the invention reveals that an artisan would not find claim 32 obvious in light of these references.

The inventors of the present invention have discovered that the unique and novel arrangement of claim 32 provides heat transfer efficiencies through development and maintenance of two-phase flow at relatively low flow rates through the porous medium. This is done by the medium providing nucleation points in close proximity to the die so that the heat transferred from the die is of a sufficient quantity to boil the liquid at said relatively low flow rates. See, for example, paragraph [0023] of the present specification.

Furthermore, this unique and novel arrangement may also provide for heat transfer efficiencies by allowing for customization of heat-transfer attributes of various areas of the thermal management device to various heat distributions over the surface of the die. For example, this arrangement may provide heat-transfer customization by

customizing porous medium characteristics, e.g., pore size, to correspond to a particular thermal energy output of an area of the die. See, e.g., paragraph [0016] and claims 34, 39, and 56. The interconnected nature of the pore channels of the porous medium may also allow for an equilibration of pressure from high to low pressure areas, which result from relatively hot and cool spots on the surface of the die. This may result in a cooling liquid (and thereby heat transfer capability) flowing to the areas associated with concentrated thermal energy. See, for example, paragraph [0024] and claim 51. These noted heat transfer efficiencies may potentially increase the overall heat transfer abilities of the apparatus recited in claim 32.

The interposing structures disposed between the thermal management devices and the dice of the cited references, whether by design or effect, diffuse and distribute the heat sourced by the die thereby failing to provide an opportunity to realize the above-identified heat transfer efficiencies discussed in relation to claim 32, for example. Accordingly, without recognition of these efficiencies and the associated invention of a device that may increase the probabilities of achieving these efficiencies, there would be no motivation in the prior art to modify these references to achieve the apparatus recited in claim 32, for example.

Accordingly, for at least these reasons, there is an insufficient factual basis for a *prima facie* case of obviousness of claim 32 in light of the cited references. Claims 33 – 45 and 50 – 58 depend from, or include limitations similar to, claim 32. Therefore, there is also an insufficient factual basis for a *prima facie* case of obviousness of these claims for at least the same reasons. Briefly, Appelants will further explain why there is insufficient teachings to overcome the other differences between the cited references and these claims mentioned above in section VII.A.2.

With respect to claim 34, as discussed above, this claim includes a limtiation related to configuring a porous medium based at least in part on non-uniform heat distribution over the surface of the die as recited by claim 34. There is nothing in the cited references that suggests this limitation as neither of the cited references make any mention of heat gradients within a die. Furthermore, there is no convincing line of

reasoning put forth in the Office Action as to why an artisan would find this limitation obvious in light of the cited references. Providing for a heat transfer management device to accommodate heat gradients over a surface of a circuit board, as is done in Dessiatoun, does not make it obvious to configuring a porous medium based at least in part on non-uniform heat distribution over the surface of the die. There is nothing to suggest that the medium of Dessiatoun is even capable of scaling to the dimensions required for accommodating thermal gradients over the face of the die, much less there being an identified motivation in the prior art to do so.

With respect to claims 39 and 56, as discussed above, these claims include limitations related to the porous medium having different pore diameters corresponding to different thermal outputs of areas of the die. For similar reasons to those given above with respect to claim 34, there is nothing in the cited references that suggests this limitation nor is there a convincing line of reasoning put forth in the Office Action as to why an artisan would find this limitation obvious in light of the cited references.

With respect to claim 42, as discussed above, this claim includes a limtiation related to a pump facilitating a fluid flow at a rate to result in two-phase flow. There is nothing in the cited references that suggests this limitation as neither of the cited references make any reference to two-phase flow. Furthermore, there is no convincing line of reasoning put forth in the Office Action as to why an artisan would find this limitation obvious in light of the cited references. The Examiner simply states that pumping the fluid rate too slowly, resulting in two-phase flow is obvious. This is the type of unsupported, conclusory statements that are consistently found insufficient to establish a *prima facie* case. “The consistent criterion for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success.” Rockwell Int’l Corp. v United States, 147 F.3d 1358 (Fed. Cir. 1998). The Examiner’s conclusory statement provides neither the desirability for the limitation of these claims, nor a reasonable likelihood of its success.

With respect to claim 43, as discussed above, this claim includes a limitation related to a substrate coupled to a die on the side opposite the thermal management device. There is nothing in the cited references that suggests this limitation as both of the cited references disclose the thermal management coupled to a circuit board, which is in turn coupled to the die. Furthermore, there is no convincing line of reasoning put forth in the Office Action as to why an artisan would find this limitation obvious in light of the cited references. While the Examiner cites other references purportedly disclosing this limitation in isolation, there is nothing to suggest that these teachings are even compatible with the thermal management devices of the cited references without significant modification, much less there being a desire to combine these teachings.

As discussed above with respect to claim 46 (and claims 47 -49), Ozmat and Dessiatoun fail to expressely or impliedly suggest a microporous medium attached to a die and disposed within a cavity of a thermal management device. Furthermore, the Examiner has also failed to provide a convincing line of reasoning as to why an artisan would be motivated to modify either of these references to correct for their deficiencies.

The shortcomings of the *prima facie* case with respect to these claims are similar to those described above with respect to claim 32. Additionally, the Examiner has failed to show that the prior art makes a microporous medium attached to the die obvious, as these limitations are used in the context of these claims.

In addition to the discoveries described above, the present inventors have also discovered that both pressure drops (i.e., flow resistance) and heat transfer capabilities are roughly inversely proportional to pore size. The apparatus recited in claim 32 presents an apparatus developed with recognition and accounting of this correlation. Embodiments of the present invention have found that such a microporous medium may provide improved heat transfer capabilities while still providing workable flow resistances. See, e.g., paragraph [0014]. Additionally, a medium with pore sizes within this scale may also facilitate other embodiments of this invention, e.g., by configuring the medium to temperature gradients within a die.

Not only do both Ozmat and Dessiatoun disclose interposing structures between a die and thermal management device, they also teach away from the use of micro-scaled porous medium. Ozmat, e.g., teaches that a preferred sponge material would be similar to steel wool, have a density of 10%, and should offer a low resistance to liquid flow, i.e., it should have large pore diameters. See *Ozmat* column 3, lines 37 – 53. Dessiatoun teaches a compressed spring made of wires with varying diameters. It is a compressed version of the smallest of these wires (with a diameter of 0.6 millimeters) that is the cause of concern for clogging and is only used in areas of high heat. Accordingly, one skilled in the art would interpret Dessiatoun to teach this size being at the lower end of the scale structure, which is still far from the micro-scale structure. See Dessiatoun paragraphs [0056] and [0075].

With respect to claim 47, as discussed above, this claim includes a limitation related to a sealant to at least facilitate a watertight seal between the case and the die. There is nothing in the cited references that suggests this limitation as both of the cited references teach the fluid being disposed within the case, therefore there is no reason to teach a watertight seal. Furthermore there is no convincing line of reasoning put forth in the Office Action as to why an artisan would find this limitation obvious in light of the cited references.

With respect to claim 48, as discussed above, this claim includes a limitation related to the porous medium being attached to the die with a thermal interface material. There is nothing in the cited references that suggests this limitation as neither of the cited references teach a porous medium being attached to a die at all. Furthermore there is no convincing line of reasoning put forth in the Office Action as to why an artisan would find this limitation obvious in light of the cited references.

With respect to claim 49, as discussed above, this claim includes a limitation related to a porous medium having dimensions similar to the die. There is nothing in the cited references that suggests this limitation as both of the cited references teach a thermal management device having dimensions similar to a circuit board, not a die. Furthermore, there is no convincing line of reasoning put forth in the Office Action as to

why an artisan would find this limitation obvious in light of the cited references. The Examiner states that a mere change in size is generally within the level of one of ordinary skill in the art. However, this is true only when it was known that the prior art is capable of being scaled to the claimed dimensions. As discussed above, there is no teaching in the prior art that the cooling structures of Ozmat or Dessiatoun are capable of being scaled to the claimed dimensions, much less there being a desire to do so.

For at least these reasons, a *prima facie* case of obviousness has not been established. Accordingly, the rejections in the Office Action are improper and the Appellants respectfully request that the BPAI allow these pending claims.

VIII. CLAIMS APPENDIX

32. An apparatus comprising:

a die including at least one integrated circuit and a surface;

a heat exchanger; and

a thermal management device having

a case with a plate attached to the surface of the die and a cavity, and

a porous medium disposed within the cavity of the case and attached to the plate, the thermal management device to allow for a fluid to flow through said porous medium to thermally couple the die to the heat exchanger.

33. The apparatus of claim 32, wherein the porous medium is attached to an entire face of the plate that is exposed within the cavity.

34. The apparatus of claim 32, wherein the at least one integrated circuit causes a non-uniform heat distribution over the surface of the die when in operation and the porous medium being configured based at least in part on said non-uniform heat distribution.

35. The apparatus of claim 34, wherein the porous medium is configured with an area having a plurality of pores elongated in a direction.

36. The apparatus of claim 32, wherein the fluid is a selected one of air, water, and perfluorinated liquid.

37. The apparatus of claim 32, wherein the porous medium includes a porous metal foam.

38. The apparatus of claim 32, wherein the porous medium includes a plurality of pore channels with a pore diameter that is substantially at or between 50 μm – 1 mm.

39. The apparatus of claim 32, wherein the die includes a first area having a first thermal energy output and a second area having a second thermal energy output, which is different than the first thermal energy output, and the porous medium including a first portion, corresponding to the first area, having a first average pore diameter and a second portion, corresponding to the second area, having a second average pore diameter, which is different than the first average pore diameter.

40. The apparatus of claim 32, wherein the porous medium includes a porosity that is substantially at or above 80%.

41. The apparatus of claim 32, wherein the case includes:

an inlet coupled to a pump;

an outlet coupled to the heat exchanger; and

the pump to facilitate fluid flow through the porous medium toward the heat exchanger.

42. The apparatus of claim 41, wherein the pump is to facilitate a fluid flow at rate to result in a two-phase fluid flow.

43. The apparatus of claim 32, wherein the surface is a first surface of the die and the apparatus further comprises:

a substrate coupled to a second surface of the die, which is opposite the first surface.

44. The apparatus of claim 32, wherein said fluid flow through said porous medium is primarily induced by natural buoyancy resulting from the fluid absorbing thermal energy output from the die.

45. The apparatus of claim 44, wherein the case hermetically encompasses the porous medium.

46. An apparatus comprising:

a die including at least one integrated circuit;

a heat exchanger; and

a thermal management device having a case including a cavity and a mircroporous medium attached to the die and disposed within the cavity, the thermal management device to allow for a fluid to flow through said porous medium to thermally couple the die to the heat exchanger.

47. The apparatus of claim 46, further comprising:

a sealant to at least facilitate a watertight seal between the case and the die.

48. The apparatus of claim 46, wherein the porous medium is attached to the die with a thermal interface material.

49. The apparatus of claim 46, wherein the die has a length, a width, and a height, and the porous medium has a length and a width that are approximately equal to the length and the width of the die.

50. A method comprising:

operating an integrated circuit within a die, leading to heat being sourced from the die; and

flowing a fluid through a porous medium housed in and filling a cavity of a case that is attached to the die, to transfer thermal energy away from the die.

51. The method of claim 50, wherein said operating of the integrated circuit further leads to heat being sourced in a first amount from a first area and a second amount from a second area, the first amount being different from the second amount resulting in

a relatively high-pressure portion of the porous medium corresponding to the first area and a relatively low-pressure portion of the porous medium corresponding to the second area and the method further comprises:

equilibrating an overall pressure of the liquid flowing through the porous medium.

52. The method of claim 50, wherein the porous medium includes a plurality of pore channels with a pore diameter that is substantially at or between 50 μm – 1 mm.

53. The method of claim 50, wherein said flowing of a fluid is induced by natural buoyancy resulting from heated portions of the fluid.

54. A system comprising:

an electronic assembly including:

a die including at least one integrated circuit and a surface;

a heat exchanger; and

a thermal management device having

a case with a plate attached to the surface of the die and a cavity, and

a porous medium disposed within the cavity of the case and attached to the plate, the thermal management device to allow for a fluid to flow through said porous medium to thermally couple the die to the heat exchanger;

a dynamic random access memory coupled to the at least one integrated circuit; and

an input/output interface coupled to the at least one integrated circuit.

55. The system of claim 54, wherein the porous medium includes a plurality of pore channels with a pore diameter that is substantially at or between 50 μm – 1 mm.

56. The system of claim 54, wherein the die includes a first area having a first thermal energy output and a second area having a second thermal energy output, which is different than the first thermal energy output, and the porous medium including a first portion, corresponding to the first area, having a first average pore diameter and a second portion, corresponding to the second area, having a second average pore diameter, which is different than the first average pore diameter.

57. The system of claim 54, wherein the system is a set-top box, an entertainment unit, or a digital versatile disk player.

58. The system of claim 54, wherein the input/output interface comprises a networking interface.

IX. EVIDENCE APPENDIX

None.

X. RELATED PROCEEDINGS APPENDIX

None.

CONCLUSION

Appellant respectfully submits that all the appealed claims in this application are patentable and requests that the BPAI overrule the Examiner and direct allowance of the rejected claims.

This brief is submitted in triplicate, along with a check for $500 to cover the appeal fee for one other than a small entity as specified in 37 C.F.R. § 1.17(c). Additionally, we submit herewith a petition and fees for an extension of time for response within a first extension period according to 37 C.F.R. § 1.136(a). We do not believe any other fees are needed. However, should that be necessary, please charge our Deposit Account No. 500393. In addition, please credit any overages to the same account.

SCHWABE, WILLIAMSON & WYATT, P.C.

Dated: 02/21/2007

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